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25X1

PAR 224

1 June 64

SUBJECT: 3 - 15X Fluid Gate Enlarger

TASK/PROBLEM

1. Develop and fabricate an enlarger having continuously variable magnification from 3X to 15X for a 70mm square negative gate size. Print sizes to range up to 40 x 40 inches on cut-sheet stock.

DISCUSSION

2. Authorization to proceed on this project was received 2 Mar 64. Design studies applicable to this project and to PAR 202 were started early in April. Manpower in the design group responsible for these projects is being increased as engineers are available and as they can be used efficiently. Design studies started during the quarter were:

a. Mechanical design of the negative transport system. These studies include loops of film with a metered scale coupled to film driven metering rolls to measure (1) along-frame coordinate, and (2) frame number.

b. Possible enlarger arrangement to provide a horizontal print stock platen surface and a convenient fixed position for the vertical gate negative handling system by folding the optical path. No successful arrangement was found. The primary problem is the required size of the mirror -- about 20 x 30 inches! The problems in fabrication, mounting and maintenance of such a mirror would exceed gains in operational convenience from its use. We recommend a horizontal axis optical system without a mirror.

c. As part of the enlarger arrangement study we have proposed design parameters for a set of three objective lenses. These lenses will work at over-all conjugate lengths of 50 to 80 inches with optimum image quality at 61.5 inches. The shortest focal length lens of the set (EF = 4.7 inches) provides 8.6X to 15X magnification and is the same as the longest focal length lens of the set of four lenses proposed for PAR 202, Briefing Print Enlarger (10X-60X). A single lens design specification (Attachment Specification 469-319) has been written for a "family" of six lenses serving the requirements of both PAR 224 and PAR 202 for color blind print stock and is attached for information.

Declass Review by NGA.

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PLANNED ACTIVITY

3. During the next quarter we will:

a. Let contracts for design of the family of lenses for color blind print stock.

b. Complete the specification and let contracts for the family of color corrected lenses.

c. Begin fabrication of the breadboard model of the negative transport system.

d. Make design studies and build breadboard models for vacuum platen system.

e. Make design studies on the platen and lens focusing system.

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PAR 224

Spec No. 469-319

Date 1 June 64

SPECIFICATION
FOR
ENLARGER LENSES
4600A

1.0 Objective and Condenser Lens Sets for 3X to 60X Fluid Gate Enlarger for noncolor sensitized print stock.

2.0 This specification describes a "family" of six objective and condenser lens sets to be used in a maximum performance fluid gate enlarger for high definition black and white aerial photographs.

We are authorized to develop components and the design concept for the proposed enlarger, including the design, fabrication and testing of prototype lenses. It is desired to have lens samples ready for testing by 1 February 1965.

3.0 UNUSUAL REQUIREMENTS

3.1 The enlarger must provide any magnification ratio to a 20" x 24" print in the range 10X to 60X and provide any magnification ratio from a 70mm square negative area in the range 3X to 15X. The curves of Figure 1 were derived by thin lens formulae and show a tentative set of six (6) lenses meeting the requirements with a maximum semifield angle of 20° and with object-to-image distance (O.A.C.) of 50 to 80 inches.

3.2 The negative will be held between flat glass surfaces wet by an index matching fluid, such as tetrachloroethylene or Freon-113. It is suggested that the glass element on the objective side of the negative be a plano-concave field-flattener. The glass element on the lamp side of the negative may be a plano-convex element of the condenser system.

3.3 The condenser system should include a 4mm thick heat absorber (Pittsburgh No. 2043) and allow space (perhaps 0.25 inch) for insertion of a color filter far enough removed from the lamp to avoid overheating it.

3.4 The proposed lamp is the 300 watt Code CRA lamp having a six coil monoplane filament 8.5 x 8.9 mm. It is suggested that the 12.3mm filament diagonal be projected to fill 95% of the diameter of the projector lens aperture. The envelope of the CRA lamp is 0.56 to 0.69 inch from the filament plane.

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3.5 The use of a methacrylate condenser element with an aspheric surface may be considered where adequate spherical correction of the condenser system would otherwise require several elements.

The plastic element cannot be in contact with the negative and the immersion fluid nor next to the lamp.

4.0 FOCAL LENGTH

See Table 1

5.0 RELATIVE APERTURE

See Table 1. The apertures specified may be reduced (increased f/no) by 30% if improved definition can be achieved. The lens aperture will be fixed in fabrication and need not be capable of later adjustment.

6.0 FIELD OF VIEW

See Table 1.

7.0 MAGNAFICATION

See Table 1.

8.0 FIELD ILLUMINANCE OR VIGNETTING

The illuminance at the maximum field radius specified in Table 1 shall not be less than 70% of that on the system axis.

9.0 TRANSMITTANCE

Not specified.

10.0 ACHROMATISM

The system will be used with a second order Fabry-Perot filter with peak transmittance at 460 mu. and half-pass band width of about 9 mu. Short range achromatization is suggested.

11.0 SPACE OR SIZE LIMITATIONS

See Table 1. Also, the lamp-centerline-to-negative-plane distance should not exceed about ten (10) inches. If this becomes difficult, please consult the project engineer.

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Spec No. 469-319

Date 1 June 64

SPECIFICATION
FOR
OBJECTIVE LENS SET FOR 3X TO 60X FLUID GATE ENLARGER

Lens	Nom. E.F.	Relative Aperture	Magn.	O.A.C.	Field Raduis Short Conj.	Field Raduis Long Conj.	Approx. Field Angle
A	10.7	f/17.8	2.5X	52.5	2.00	5	7° 35'
			3.45	61.5	2.00	6.9	8° 15'
			5.3	80	2.00	10.6	8° 55'
B	7.2	f/12	4.75X	50.0	2.00	9.5	12° 55'
			6.40	61.5	2.00	12.8	13° 30'
			9.0	80	2.00	18	14°
C	4.7	f/7.8	8.55X	50.0	1.90	16.25	19° 50'
			11.0	61.5	1.90	20.9	20° 20'
			15.0	80	1.90	28.5	20° 45'
D	3.0	f/5	14.5X	50.0	1.08	15.6	18° 25'
			18.5	61.5	1.08	20.0	19°
			24.7	80	1.15	28.28	20° 10'
E	1.9	f/4.2	24.2X	50.0	0.645	15.6	18°
			30.5	61.5	0.645	19.7	18° 15'
			40.2	80	0.703	28.28	19° 35'
F	1.25	f/2.8	38.X	50.0	0.410	15.6	17° 45'
			47	61.5	0.410	19.3	17° 45'
			62.5	80	0.452	28.28	19° 45'

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12.0 SPECIAL MATERIALS

Domestic glass is desired but if higher performance is obtainable with imported glass it should be used.

13.0 PERFORMANCE

For each of the six lens designs as computed at 61.5" over-all conjugate and λ = 460 mu. the design goal is to have 90% of the computed rays fall within:

a. A circle equal to the diameter of the first minimum of the diffraction pattern to 6° (or more) off axis,

b. A circle twice the diameter of the first minimum to 12° (or more) off axis, and

c. A circle 4X the diameter of the first minimum to 18° (or more) off axis.

13.1 Report

Upon completion of the designs the project engineer requires formula sheets and energy distribution diagrams and/or spot diagrams at 0°, 6°, 12°, and 18° off axis for the three over-all conjugate distances indicated in Table 1 for each of the six designs before sample fabrication is begun.

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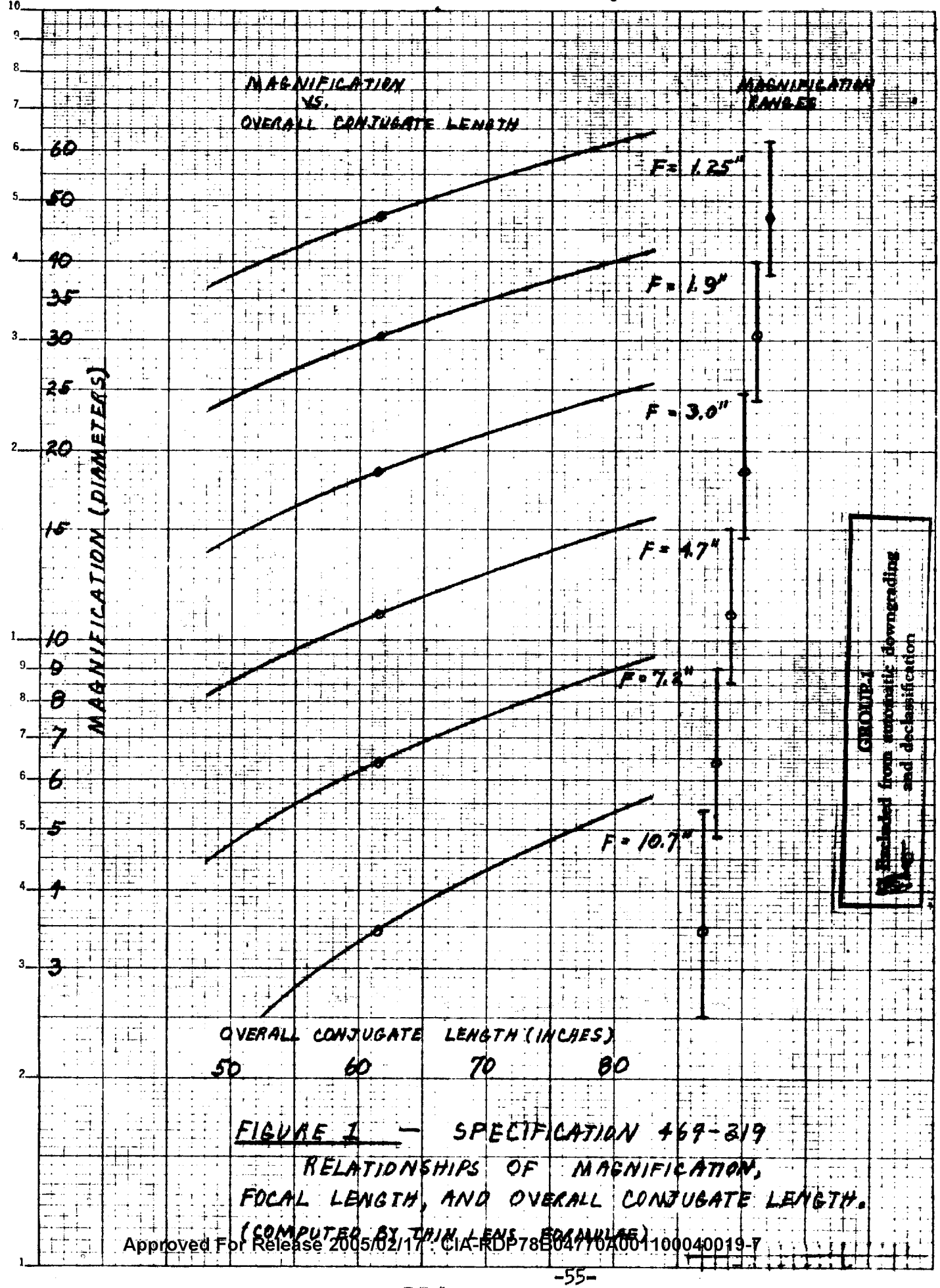

FIGURE 1 — SPECIFICATION 469-319
RELATIONSHIPS OF MAGNIFICATION, FOCAL LENGTH, AND OVERALL CONJUGATE LENGTH.
(COMPUTED BY THIN LENS FORMULAE)

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